



Industrial Consultancy & Sponsored Research (IC&SR)

A Jet Impingement Cooling System with Improved Showerhead Arrangement for Gas Turbine Blades

IITM Technology Available for Licensing

PROBLEM STATEMENT

- ❑ Gas turbines are crucial in aerospace and power industries, with efficiency being a key criterion.
- ❑ Jet impingement cooling is effective, but blade material safety limits are a concern.
- ❑ Several proposals have been proposed to improve turbine airfoil cooling performance,
- ❑ Including multiple impingement cooling circuits, projecting ribs or fins, flow channels, and multiple features for cooling.
- ❑ However, these methods can lead to pressure loss and backward flow of cooled air.
- ❑ The addition of projections can increase convective heat transfer area but increase blade weight,
- ❑ Indirectly reducing turbine engine efficiency and potentially leading to thermal stresses.
- ❑ A cooling system with reduced impingement cooling circuits and 3-D protrusions is needed.

TECHNOLOGY CATEGORY MARKET

Technology: Cooling system of turbine blades

Category: Aerospace & Defense Technologies

Industry: Aviation

Application: Cooling system in Powering aircraft

Market: The global gas turbine services market size was valued at **USD 33.9 billion in 2022** and is projected to grow at a compound annual growth rate (CAGR) of **8.7% from 2023 to 2030**.

INTELLECTUAL PROPERTY

IITM IDF Ref. 1598, Patent No: IN 346399

PCT/IN2018/050615

TRL (Technology Readiness Level)

TRL- 3, Experimental Proof of Concept;

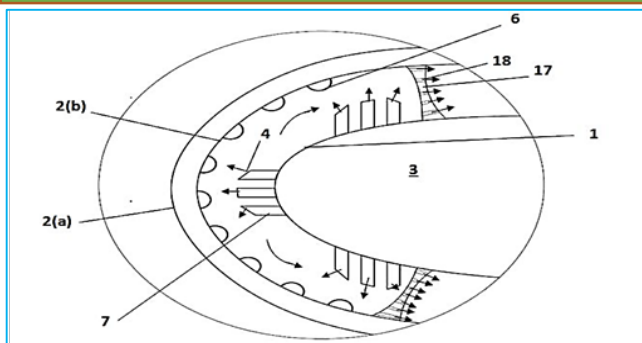
Research Lab

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TECHNOLOGY

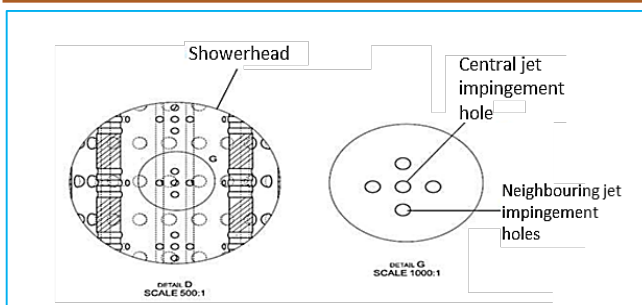
- Utilizes jet impingement cooling system.
- Includes structurally supported impingement inserts and holes/impingement tubes for cooling the leading edge.
- Cooled air from a chamber passes through the tubes, while hot gases pass through the trailing edge.
- A chamfer is made at the exit of the tubes, ensuring uniformity and extension in cooling coverage.
- 3-D hemispherical protrusions are disposed at the inner wall of the leading edge for further heat transfer enhancement.

Assembly with impingement tubes fitted to the impingement inserts



- 1-Impingement insert
- 2-Leading edge of blade/vane[2a-outer wall,2b-inner wall]
- 3-Outer wall of air supply chamber
- 6-Protrusions,7-Jet impingement tubes
- 17-Inverted C-shaped support
- 18-Branched of inverted C-support

Jet impingement inserts arranged in showerhead fashion.



CONTACT US

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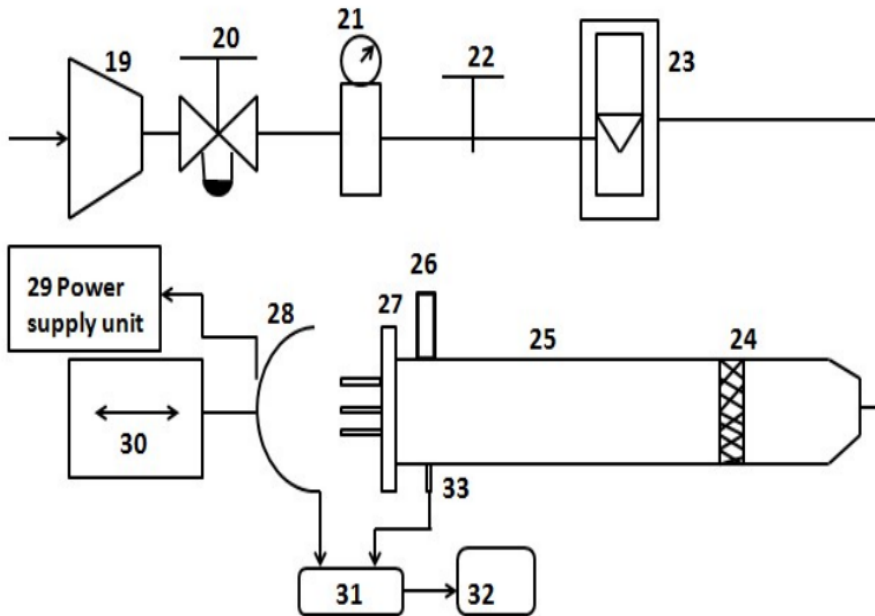
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Experimental setup



Numerals	Definition
19	Air Compressor
20	Filter-Regulator cum moisture separator
21	Pressure gage
22	Needle valve
23	Rotameter
24	Wire screen mesh
25	Settling Chamber (long pipe)
26	Pressure transducer
27	Flange containing jet impingement tubes
28	Test section
29	Power supply and measuring unit
30	Traversing mechanism
31	Data logger
32	Personal computer
33	Thermocouples

Key Features / Value Proposition

Jet cooling & Formation of showerhead

- achieved by **directing cooled** air through impingement inserts with cylindrical holes, forming a showerhead.

Reduction in Blade weight

- The **cylindrical holes** form a **showerhead**, resulting in **3-D protrusions** on the inner wall of the leading edge, acting as **turbulent promoters** and reducing blade weight.

Cooling Insert

- Introduces **impingement cooling inserts** for turbine blade assembly, providing **cooled air path for impingement cooling** of the leading edge of the blade.

Showerhead Arrangement

- The shower head arrangement includes **multiple jet impingement holes/tubes**, modified by **chamfering one end facing the blade's leading edge**.

Coolant requirements

- The arrangement has **homogeneous flow**, **enhances heat transfer**, and extends cooling coverage on the **blade's leading edge**, reducing coolant requirements

Key Performance

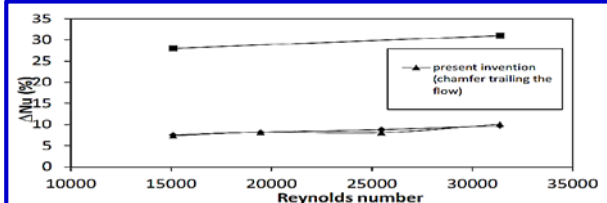
- The showerhead arrangement and impingement holes/tubes **reduce coolant flow** by **reducing the number of holes**.

Edge distance

- The chamfering can be led or trailed based on turbine operating conditions and **jet-to-leading edge distance**.

Heat transfer

- 3-D protrusions in in-line** or staggered arrays are used to **modify the inner leading edge surface** for enhanced heat transfer



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